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ABSTRACT

This instructional unit is one of 10 developed by students on various energy-related areas that deals specifically with energy sources and development. Its objective is for the student to be able to discuss energy sources and development related to the historical perspective, biological development, current aspects, and future expectations concerning energy usage. Some topics covered are current exploration for petroleum resources, factors related to the expansion of the natural gas industry, advantages of strip mining as compared to underground mining, and fuel usage and effect on the environment. Material in each unit may include some or all of the following: terminal and specific objectives, list of references, information sheet with terms and definitions, informative materials, transparency masters, assignment sheet(s), and unit test with answers. (YLB)

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ENERGY SOURCES AND DEVELOPMENT

by

Ron Crank

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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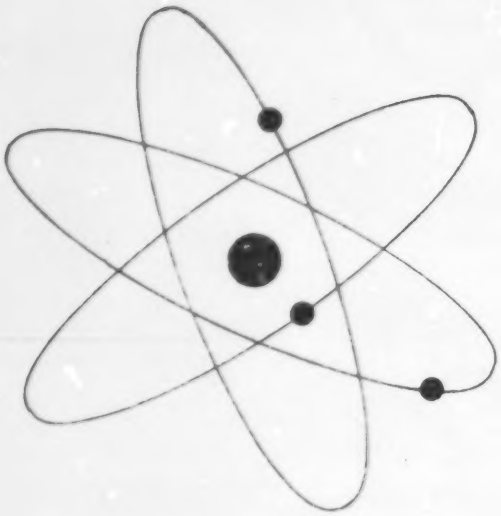

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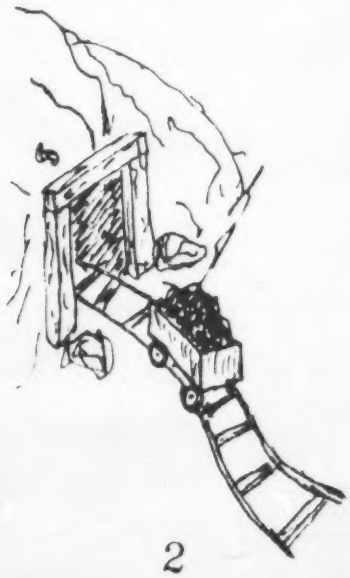

ENERGY SOURCES AND DEVELOPMENT

TERMINAL OBJECTIVE

Upon completion of this unit, the student will be able to discuss major areas of energy sources and development related to the historical perspective, biological development, current aspects and future expectations concerning the usage of energy.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Select correct factual information concerning types of energy from those statements which are not factual.
2. Match definitions concerning energy fuel types to terminology concerning the kind of fuel.
3. Name three areas under consideration in current exploration for petroleum resources.
4. Discuss three uses of petroleum products in the early days of development.
5. List three factors related to the expansion of the natural gas industry.
6. Compare the advantages of strip mining to that of underground mining.

ENERGY SOURCES AND DEVELOPMENT

INFORMATION SHEET

I. Terms and Definitions

A. Anaerobic -- occuring in the absence of air or free oxygen.

B. Anaerobic digestion -- use of bacteria to reduce waste to methane and sludge.

C. Anthracite -- hard compact natural coal of high luster differing from bituminous coal in containing only a small amount of volatile matter and burning with nearly smokeless flame. Coal of the highest grade containing the lowest percentage of sulfur.

D. Atmosphere -- gaseous envelope surrounding a celestial object.

E. Atom -- smallest particle of an element that can exist alone or in combination with similar particles of the same or a different element.

F. Bioconversion -- converting biological materials normally considered wastes into energy.

G. Biosphere -- zone of air, land, and water at surface of the earth that is occupied by living organisms.

H. Bitumen -- any of various mixtures of hydrocarbons (as asphalt, crude petroleum, or tar). Occuring naturally or obtained as residues from naturally occuring substances by heat refining.

I. Bituminous coal -- Coal that yields considerable bituminous (hydrocarbon) matter when heated. Also known as soft coal.

J. Black lung -- disease of coal miners in which coal dust is inhaled in quantities that overpower lungs-cleaning mechanisms. Leads to cell damage that produces form of emphysema.

K. Entrophication -- ultimate state reached in degradation of the matter and energy of the universe.

L. Fission -- process of cleaning, splitting, or breaking into parts. Splitting of an atomic nucleus (as by bombarding with neutrons) especially into approximately equal parts resulting in release of enormous quantities of energy when certain heavy elements are split (such as uranium and plutonium).

M. Fusion -- Union of atomic nuclei to form heavier nuclei resulting in the release of enormous quantities of energy when certain light elements unite (as in the combination of heavy-hydrogen nuclei to form helium nuclei that take place in the sun or in a hydrogen bomb).

N. Geothermal -- natural heat of the earth captured by means of subsurface fluids.

O. Gasification (of coal) -- the conversion of coal to gaseous fuel.

P. Hydrocarbons -- large class of organic compounds containing only carbon and hydrogen.

Q. Hydrogenation -- to combine with hydrogen or to treat with or expose to hydrogen.

R. Humidification -- process of conversion plant material to coal; CO_2 and methane driven off, water removed. Residue rich in carbon.

S. In-situ -- in the natural or original position or location.

T. Isotope -- One of two or more species of atoms of the same chemical element that has the same atomic number and occupy same position in periodic table and that are nearly identical in chemical behavior but differ in atomic mass - but behave differently in radioactive transformations and in physical properties and may be detected and separated by means of these differences.

U. Kerogen -- bituminous material occuring especially in oil shale and yielding oil when heated.

V. Kerosene -- flammable hydrocarbon oil used for burning in lamps, heaters, and furnaces; fuel competent for jet engines and as solvent or thinner.

W. Lignite -- brownish-black coal in which alteration of organic material has proceeded farther than peat but not as far as bituminous coal.

X. Liquefaction -- conversion of coal into liquid hydrocarbons and related compounds by hydrogenation.

Y. Magma -- molten rock material within the earth from which an igneous rock results by cooling and crystallization.

Z. Methane -- colorless odorless flammable gaseous saturated hydro-carbon CH_4 that is lighter than air and forms explosive mixtures with air or oxygen, occurs naturally as a product of decomposition of organic matter in marches and mines.

AA. Organic -- pertaining to, or derived from, living organisms. Dealing with compounds of carbon.

BB. Refining -- action or process of removing impurities from crude or impure material -- petroleum; fractional distillation usually followed by other processing (or cracking).

CC. Seismic -- Shock or earth vibrations produced by earthquake or artificially by geophsical prospecting.

DD. Sour-crude - high sulfur crude oil.

EE. Strip-mining -- mining of coal by removing covering material (over burden) and "stripping" away entire underlying coal seam.

FF. Subsidence -- cave-ins caused by weakening of earthen layer due to underground mining.

GG. Sweet-crude -- low sulfur crude oil.

HH. Sweetening process -- process of removing sulfur from crude oil.

II. "Wild-catting" -- to drill or prospect an experimental oil or gas well in territory not known to be productive.

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ENERGY SOURCES AND DEVELOPMENT

The understanding of energy conservation and the care of natural resources must begin with an awareness of their beginning. We also must be knowledgeable in how various fuel sources were developed and what uses were and are being made of these energy sources.

Based on the current definition fuels are energy source materials that are becoming much broader in meaning. Conventional fuels are those from the fossils of many years of development. Petroleum, natural gas, coal, lignite and peat are the terms we know the conventional fuels by name. Fossil fuels were formed by the decomposition of vegetable matter without the benefit of air under varying degrees of temperature and pressure over long periods of time. We will discuss this process in more detail. The fuels from fossil development are used in the production of gasoline, fuel oils and distillables and also are burned in their raw natural state.

Energy fuel also includes sources from nuclear, electrical, bromass conversion, solar utilization, geothermal and hydro and wind generation or conversion.

Nuclear fuels can be classified into fission and fusion fuels. Fission includes uranium and plutonium. Fusion elements include deterium, lithium and others. Biomass fuels include municipal and industrial solid waste as well as agricultural products like wood, bark, crop residues and animal waste. Solar energy includes the direct radiation effect from the sun. This radiation can be converted into thermal and or electrical energy. We will discuss the elements of nuclear, biomass and solar energy concepts further.

Geothermal energy is the heat contained in the molten core mass of the earth. It results from the release of steam and hot water at or below the earth's surface. The potential energy of the ocean currents and water movement must also be considered.

The importance of electricity as an energy source cannot be left out of our list of basic resources. The generation of electric energy is by conversion of many of the previously mentioned fuel sources. This conversion is important because of the efficiency and utility advantages of electric power as a basic supplement for other energy sources.

We begin our exploration of energy sources and development with a closer look at fossil fuels.

Man first discovered fossil fuels after his existence on earth two million years. He discovered that certain rocks would burn or the substance we call oil shale. He also discovered petroleum. It is estimated that mankind will have burned all the fossil fuels, within 1500 years of discovery, that can be taken or recovered from the earth. This period of burning will be quite brief compared to the overall history of man in relation to time.

The fossil fuel family includes crude oil, natural gas, tar sands, coal, lignite, oil shale and peat. This is also referred to as the petroleum family of hydrocarbons.

Some theories have developed about the formation of fossil fuels. The oldest known petroleum was formed over a half-billion years ago. Most commercial deposits are less than half as old or about 250 million years old. The formation of fossil fuel is continuing and early stages of formation can still be observed. Some current formations can be observed in the Black Sea and Mexican Gulf.

When petroleum was just beginning to form some 250 to 500 million years ago, the earth was very different. Marine life was plentiful in the shallow seas and coastal waters. Life in these waters consisted of all the major groups of animals except vertebrates. Anaerobic microorganisms lived in the stagnate areas of the sea. They could survive there because they did not use oxygen to be able to live. When plant life began, oxygen was dispersed into the air and water. Many plants could not live in water that was part oxygen. They died and settled into the bottom mud. The corpses and remains were then decomposed. A residue of hydrocarbon molecules were left behind. This process continued, adding more layers of decomposed materials. The accumulation of the sediments increased the pressure and temperature at each level. The structure of the materials were changed by this heat and pressure into different molecules aided by microbes. It took many years for this action to convert organic sediments into oil.

The first stages of oil development were believed to take from 3,000 to 9,000 years. The organic sediments contained a large amount of sea water. These sediments were continually buried under layers of mud and organic matter. Droplets of petroleum formed and dispersed into the sea water. The oily liquid moved out and up as the earth moved and pressure increased. Therefore, rocks were made firm and eventually the petroleum separated from the water. It sank lower than water because it will not allow water or oxygen to enter. It rises higher than water because of the lower density. Petroleum could leave the rocks in which it was formed. It moves through the porous surface of the rock. Some petroleum becomes trapped by non-porous rock and collects into pools of oil. The porous rock is filled

with the denser petroleum instead of ground water.

Forms of petroleum range from tarry compounds to methane gas. The tarry and wax compound have a molecular weight of 300 or more and a boiling point of 500° C. The other end of the scale, methane, has a weight of 16. The petroleum molecules vary in weight due to different amounts of oxygen, nitrogen and sulfur. Usually methane mixes with the liquid petroleum. When there is an excess of gas it bubbles to the surface or top. This is how a cap of gas was formed over the "oil pool" under a hard rock layer.

There exists very high pressure on the gas, oil and ground water. Refer to the illustration that shows the formation of layer of hydrocarbons. The pressure becomes sufficient enough to cause the surrounding material to explode or "blow outs". When this pressure is controlled properly it can aid the removal of oil and gas. Whenever cracks in the surrounding material occur the escape of oil and gas happen naturally.

Natural cracks caused seeps of petroleum to occur. Many thousands of years ago ancient civilizations road their chariots over roads paved with asphalt. The Greeks used natural petroleum for weapons. Blazing jets of escaping natural gas was worshipped by ancient fire worshippers. The Egyptians used materials from natural petroleum seeps for the preparation of mummies. Asphalt was used to caulk boats in the Middle East and on the American coasts. The Biomese are said to have collected oil of surface seeps and shallow hand-dug wells for centuries.

The discovery of oil was a chance occurance. Often oil was found by chance digging in the area of a natural seep. The industry

that we know today that involves fossil fuels began in the nineteenth century. In 1848, while searching for water, Colonel Edwin Drake, struck oil in California. Thereafter, he drilled for oil on purpose. The drilling by chance was termed "wild catting" and was unproductive for the most part. The first oil well was only slightly less than seventy feet deep and required little drilling efforts.

Oil became important when whale oil and other common lighting materials became scarce. Coal, formed in the layers of the earth, much in the same manner as other fossil fuel also became an important fuel source. Coal was discovered on the northeast coast of England near the village of Newcastle. Since the discovery of coal in the twelth century until the needs of the industrialization era coal was not fully utilized.

Coal, like oil, was found at various depths. Both deep mining and methods of extracting coal near the surface were developed. When the burning of wood had depleted all of the forest of England the burning of coal became a natural substitute. As we can envision the need for oil, gas and coal developed as other resources were depleted and the needs of mankind changed.

First let us look at how the oil industry was developed and then natural gas and coal in that order. In 1855, some geologists were pointing out that oil pools formed in certain locations. The location of oil and gas occurred in certain types of geological structures. The search for oil became more scientific and other areas of the country were found to have similar geology. The oil industry spread to the field of Pennsylvania and onto the ranges of Texas and Oklahoma. As the amount of oil became more plentiful, the development of its usage evolved.

The first demand for products produced from petroleum was kerosene. There was a small market for some lubricating oils for small machines and conveyances. Some of the oils were used as medicines.

In the beginning oil production was much greater than the overall needs. The result was low prices and much waste. At the beginning oil could hardly be given away. The oil production industry tried to find new uses for its products. The future looked bad when the electric light was invented and used steam boilers fired by coal as a power source.

It was soon discovered that oil could fire a boiler as well as coal. The oil industry was already well developed when the automobile appeared on the scene. At the turn of the twentieth century, the invention of the motorized vehicle changed the demand for petroleum products. By 1910, coal had been replaced by fuel oil in many markets served by coal. There was a rapid growth for oil in domestic use and generation of electricity. Oil had entered manufacturing, shipping and the railroads. Americans needed more oil as the popularity and usage of the internal combustion engines grew. The demand for crude oil increased at a rapid rate as more oil was recovered.

Science played an important role in the development of oil production. Geologist and petroleum engineers discovered new methods of finding and drilling for oil. Using seismic exploration, electrical analysis, gravitational methods and technology of all kinds to increase production. Exploration has gone from populated areas and land area to other geography. Drilling now takes place at the bottom of the ocean, on offshore sites and in desolate areas. The American

technology was used to develop the oil fields of the Middle East and today the colder regions of the earth like Alaska.

The development of natural gas was much different than petroleum products. Natural gas was a nuisance to the early oil industry workers. The search for oil usually found gas first before striking an "oil pool". There was little awareness or technological ability to capture the methane gas and use it productively. Therefore, much of the gas was allowed to escape into the atmosphere. Drillers burned much of the gas at the well head. It is estimated that 90% of the gas in Texas, Oklahoma and California fields were burned or otherwise lost in the early 1900's. Only a small amount was salvaged for use in the immediate vicinity of the oil fields.

The early problems related to natural gas were mostly those of ignorance and technological need. Many uses of other heating and cooking fuels meant that gas was not believed to serve as well. During the 1920's the development of high pressure pipe, improved welding techniques and power equipment for laying pipe encouraged gas usage. Up until these technological advances there was no way practical to deliver gas from the gas field to the customer. With the laying of natural gas lines to populated areas it became possible to deliver gas at reasonable rates. The discovery of oil and gas together helped promote the use of gas as more oil was required and developed.

The consumer quickly learned that the gas was a clean fuel and required no storage lines or tanks. Natural gas was available, just like water, without any investment other than that portion used each day.

Natural gas could be burned in simple, inexpensive, almost maintenance free furnaces and stoves. The use of natural gas for home heating, industrial heating and electric power generation became its most desired usage. Gas replaced both fuel oil and coal as a heating source because of the cleaner burning aspects. The ease of handling, along with clean environment factors, also meant that gas was favored in electric generating plants to fire boilers.

The formation of coal began about 350 million years ago. Like petroleum the layers of plant materials collected. Carbon rich residues were left after the removal of methane gas and water from organic molecules. This dark brown jelly-like humus soaked into less destructive fragments of woody tissue. The humidified material and plant life remains collected to form peat. See the illustration on carbon formations for the detail on how these layers existed. The accumulating sediments and accompaning increases in temperature moved more water and gas from the peat. When almost nothing but the carbon remained, the heat and pressure transformed coal. The former peat deposits contract to one-tenth the thickness of the peat layers to form a coal layer.

The type of coal was made possible by the kinds of plan residues. Mostly trees and algae used to form coal from plant residues. The depth that the residues were buried and the stage of chemical alteration and age determine the quality and use of the coal.

The coal buried the deepest and the oldest in time of formation is anthracite. It is very hard and tends to burn without a large amount of smoke when flaming. Lignite coal and bituminous

coal are 150 million and 300 million years old in formation.

The remaining kind of coal is oil shale. Refer to the illustration on carbons. It is a special type of coal containing less carbon than other coals and richer in hydrogen. This coal contains large amounts of inorganic matter. The organic part was derived from pollen, spores and algae rather than the leafy and woody plant materials used to form other types.

The scarcity of wood contributed to the development of coal as a source of fuel. By the beginning of the eighteenth century practically all the forest in England had been cut for fuel. The need of coal for heating fuel spread to industry and commerce.

The development of the first steam engine, invented by Newcomen, meant the utilization of coal to create mechanical power. In America, rapid national expansion caused depletion of wood fuels by the 1850's. These wood shortages of fuel gave impetus to coal and shale oil industries. When oil was discovered in quanity the use of oil shale slowed and coal use expanded.

Coal became the primary fuel for all segments of scoiety. Industry used coal as the primary power source for the industrial revolution supplemented by oil as fuel for industry. Transportation utilized coal in coal fired steam locomotives for railroads. Arter the first world war the power generating electric plants increased coal use as the demand for electricity rose. The iron and steel industries use large amounts of coking coal to power their furnaces.

The use of wood continued only for domestic purposes mainly for woodstoves and fireplaces. The development of the natural gas

industry caused a shift to the more convenient and cleaner use of gas for domestic heating. Coal became a fuel primarily for industrial uses. Most dominant are the uses in the steel, iron, and electrical power industries. By 1970, over 60% of the electrical utilities were powered through the use of coal. The use of fossil fuels became separated into distinct areas of principal use. Natural gas dominated the heating and cooking use for homes. Petroleum utilization was most evident in products for consumption in transportation - gasoline for cars, diesel for trucks and trains. The use of coal in electrical generation and industry became the dominant consumer for the usage of coal and coke.

Energy Environment Factors

The use of various kinds of fossil fuels depended on their effect on the environment. The advantage that electrical energy has had over the use of oil, coal, and gas is the limited amount of residues. The use of coal in the domestic area was very much effected by the coal dust, smoke, and basic inconvenience of storage and use.

The use of oil for fuel required storage, delivery and not a really desirable clean burning heating fuel. The carbons caused by the internal combustion engine became a problem in major population centers with heavy automobile traffic. The demand for electricity increased because it was clean, convenient and very accessible. The demand for electric power meant increased use of both fuel oil and coal to generate more electricity. The increased use of coal caused some problems with clean air and water standards - problems in usage as well as mining of coal. The preferred coal

type for industry is the low sulfur cleaner burning kinds. As the demand increased, coal of lesser desirability and mined under different circumstances became more popular. Most of the coal used in manufacturing of metals is already owned or contracted to steel producers. The new mining required to fuel power plants involved deeper mines and surface extraction. Coal has long been associated with environment problems as the pollution of streams and ground water, the ugliness of mines and the strip pits left on the landscape, and sickness including black lung, injury, death among miners.

The damage from mines polluted water supplies. This water could not support fish life and most aquatic plants were killed. It is also not acceptable for recreational use.

There are areas where land is sinking and providing a hazard for the population. In areas of southeastern Kansas the maze of known and forgotten tunnels are causing problems for homeowners, manufacturers and in construction. It is estimated that there are up to 60,000 abandoned coal mines in the United States. The cost of mine sealing can cost up to $20,000 per mine. One Pennsylvania community has suffered with an underground coal mine fire that has been on fire for over a decade. The only recourse now is the relocation of the entire town by the government because of the health hazzards of the fumes.

The strip mining activities of coal have contributed to enviromental problems. Strip mining occurs in about one-half of the states and provides close to 50% of the coal used today. Proper mining techniques can reduce the factors that effect the environment where regulated. Much of the history of strip mining was not

regulated and left many problems such as erosion of wind and water of surface materials being piled to the sides of pits, sediments from these piles clogging streams causing flooding and destroying fish habitats, and the damaging or destroying of crops by pollutants. Changes occur, when rock formations are disturbed, causing the formation of sulfuric acid. When this enters ground water, acid mine drainage occurs. Water supplies are contaminated with acid and high concentrations of dissolved salts. Therefore, an increase in water treatment cost occurs for nearby communities.

The processing, transportation, and storage of coal also involves pollution. Over half the coal produced in the United States is cleaned. This process pollutes water and adds over 90 billion kilograms of solid waste each year. Also, a large amount of particulate matter is released into the atmosphere. The handling of coal is very dirty and some problems occur in storage and movement with spontaneous fires and water pollution. The use and disposal of coal also contributes to pollution. The burning of coal causes excessive pollution, particularly sulfur. Typical coal-fired electric power plants generate more than just electricity. During one hour's operation while using 300,000 kilograms of coal the additional residues are distributed in the air. This is the same as seventeen tons of sulfur oxides or nearly three and a half ton of nitrogen oxides and 34 tons of ash.

The environmental factors discussed are the reasons for the development of better air and water quality standards. The Clean Air Act of 1970 provides legislation for environmental and mine safety regulation. The first reform occured in the 1950's in the

Appalachian coal area in the eastern part of the United States. The laws provided new approaches to mine operations and the control of coal use in a cleaner manner.

The use of certain devices can prevent the escape of certain particles out of coal stacks. Most of this ash can be trapped but the equipment is expensive. Operation of these pollution trapping devices consumes up to 5% of the electricity produced. The height of stacks have been increased along with decreasing the size of particles but this tends to disperse the particulates higher, wider, and more permanertly. The answer to these problems are yet to be found. Technological solutions are still in the future but experimentation is slow. The pollutants involve high cost to solve and the materials are filling our environment.

The environment is disturbed by other aspects of fossil fuel exploration, production, and usage. The drilling for petroleum offshore can cause leakages. This leakage disrupts the natural balance of life. Oil can form a slick which cuts off the surface area's oxygen supply. This causes marine life to suffocate. Birds of the sea, which get trapped by an oil slick, get oil on their feathers. They cannot get the oil off and cannot fly because of the added weight.

Pollution from refineries are evident by sight and smell. Each year refineries put twelve billion or more kilograms of sulfur oxides into the air. They also release ten billion plus kilograms of gaseous hydrocarbons. Each year the refineries let one billion kilograms of particulate matter into the air. Additional by-products of refining include ammonia, phenols, nepthalene, cresol and sulfides.

All of these do not produce a pleasant smell. The transportation and storage of petroleum present some additional problems.

Tanker spills, which are like ocean drill leaks, receive a lot of publicity by all types of media. Products of petroleum, like phenol, may be toxic to plant life and animals. Long range effects of this pollution could be the extinction of many marine species.

Another method of transportation is the use of pipelines. These pipelines also can develop leaks and pollute underground or ground water. It also could cause the plant life to die in nearby areas. The concern of the Alaska pipeline was that it could cause an imbalance of fault zones and areas of seismic activity. There was also concern about the effect of migratory herds near the Alaska pipeline. Actually, the most disruption was during the building of the pipeline and now the herds use it as shelter.

The use and disposal of petroleum add another set of environmental problems. Eighty percent of all air pollution is produced by the burning of fossil fuels. The main elements of fossil fuels are nitrogen, carbon, hydrogen and sulfur. The major problem with coal was the sulfur content we have already discussed. Power plants that are using residual fuel oil produce about the same levels of sulfur, nitrogen oxcides, and carbon monoxide as coal fired plants.

Most carbon monoxide is produced by inefficient internal combustion engines. There are three effects of carbon monoxide: Carbon monoxide competes with oxygen on the red blood cells. It accumulates in human blood during prolonged exposure periods. As a result, the person becomes less alert.

Hydrocarbons in the atmosphere undergo a chemical reaction and produce smog. The effect of hydrocarbons on the landscape is increased when they are returned to earth by rain. Some go into the earth where they are acted upon by soil bacteria. Others enter waterways and join others to add to the hydrocarbon burden of the hydrosphere. All of this represents lost energy and pollution. Some hydrocarbons are carcinogens. This means they can cause cancer and potential death to living things.

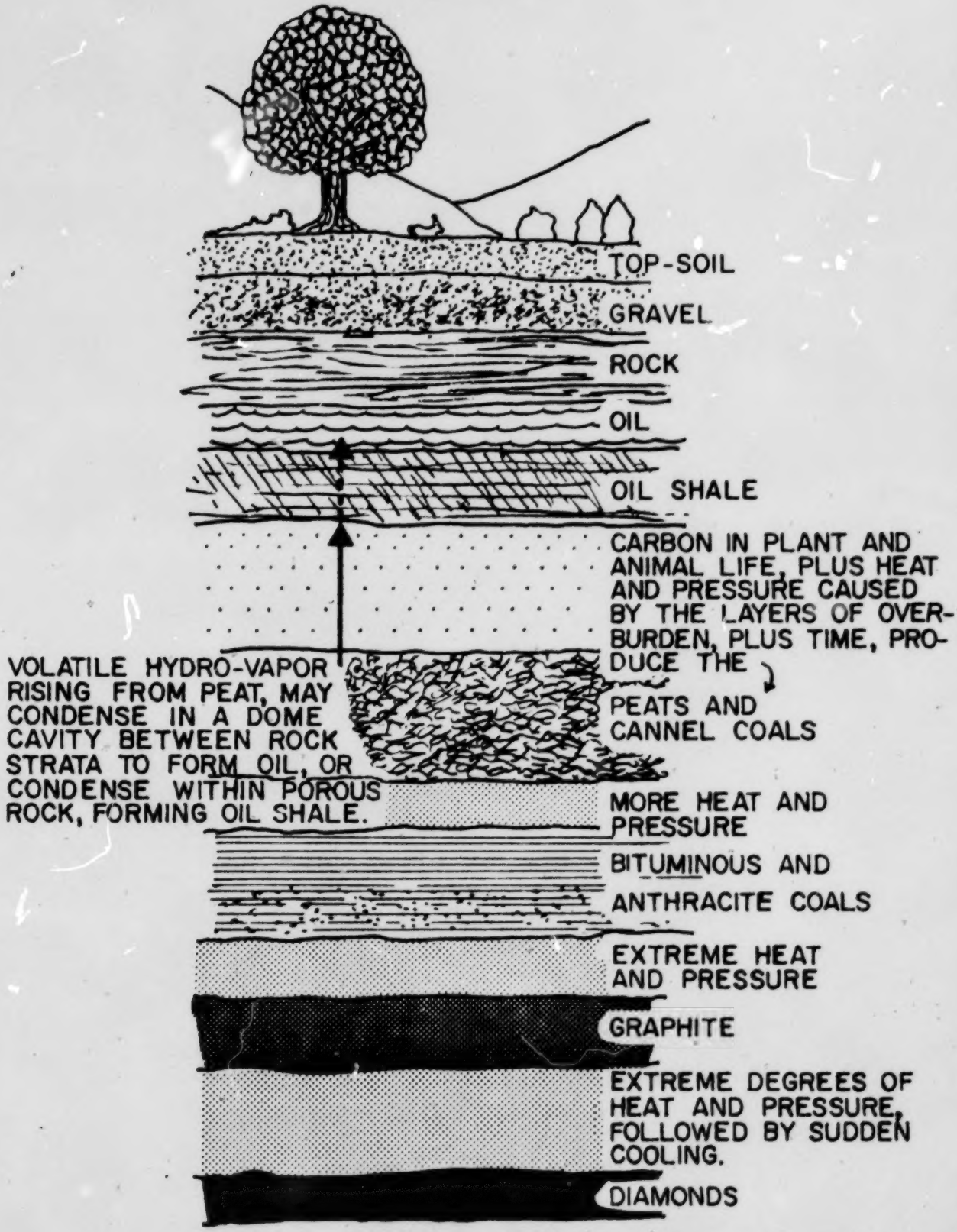
Americans realized the environmental problems of fossil fuels and particularly those caused by gasoline in vehicles. Some areas, most importantly California, have taken action to reduce auto pollution. Soon national reaction to this pollution was anti-pollution devices developed for vehicles.

The placement of smog control equipment on vehicles was necessary for environmental reasons but it had a bad effect on gasoline consumption. Changes in transportation were and are being made to solve consumption and the necessary pollution problems as well.

The people of the United States understand that there is a limit on the amount of fossil fuels available. It will take time to discover new sources and develop efficient methods to use the present sources.

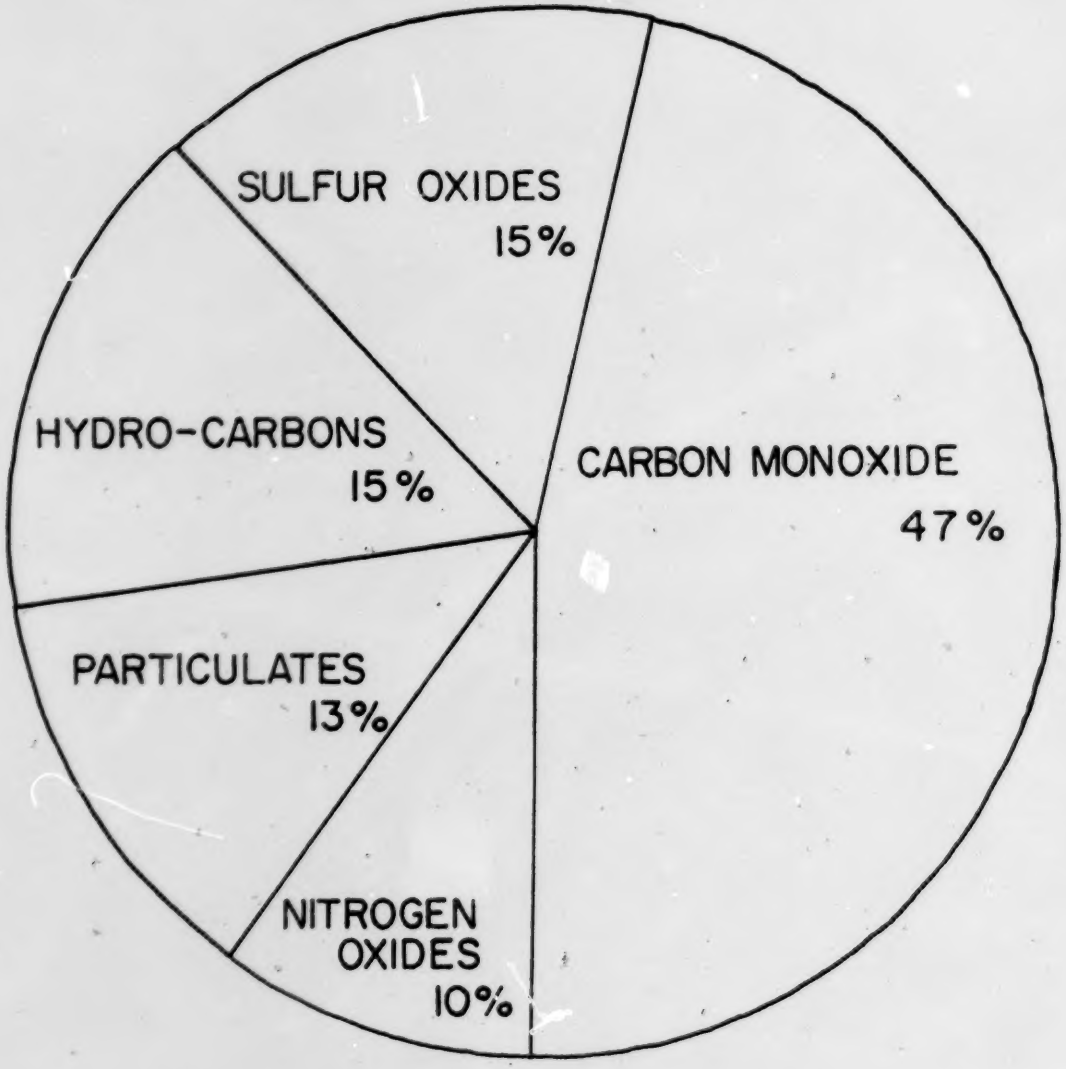
There is research on what can be done to replace fossil fuel. We will discuss the present reserves and our alternative sources further.

CARBONS

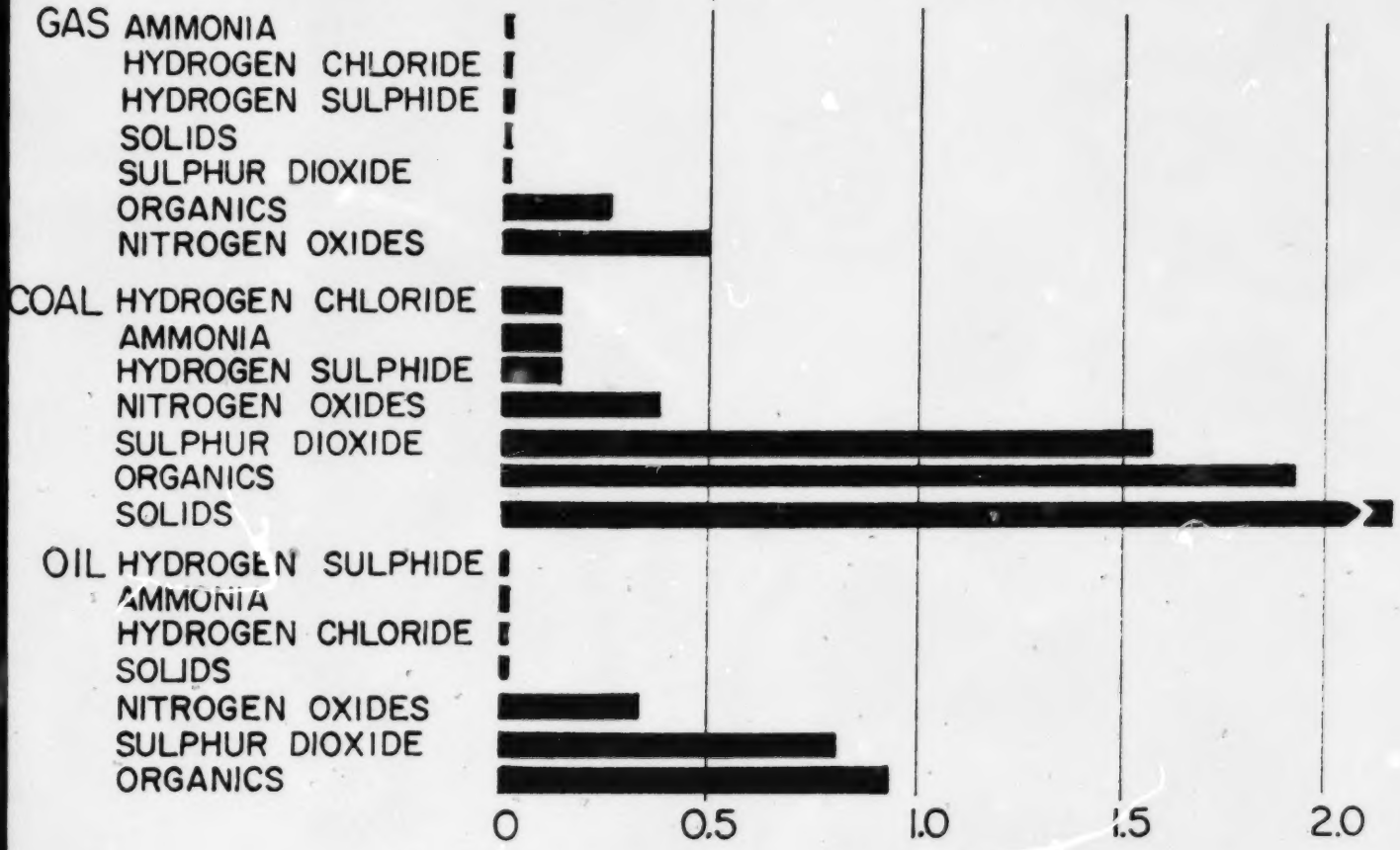

TOP-SOIL
GRAVEL
ROCK
OIL
OIL SHALE
CARBON IN PLANT AND ANIMAL LIFE, PLUS HEAT AND PRESSURE CAUSED BY THE LAYERS OF OVER-BURDEN, PLUS TIME, PRO-DUCE THE
PEATS AND CANNEL COALS
VOLATILE HYDRO-VAPOR RISING FROM PEAT, MAY CONDENSE IN A DOME CAVITY BETWEEN ROCK STRATA TO FORM OIL, OR CONDENSE WITHIN POROUS ROCK, FORMING OIL SHALE.
MORE HEAT AND PRESSURE
BITUMINOUS AND
ANTHRACITE COALS
EXTREME HEAT AND PRESSURE
GRAPHITE
EXTREME DEGREES OF HEAT AND PRESSURE, FOLLOWED BY SUDDEN COOLING.
DIAMONDS

TM I

BREAKDOWN OF COMMON POLLUTANTS BY WEIGHTS



COMPARISON OF POLLUTANTS IN FOSSIL FUELS



SOURCES OF AIR POLLUTION IN THE UNITED STATES (1968)

Sources	Carbon Monoxide 100×10^6 Tons	Sulfur Oxides 33×10^6 Tons	Hydrocarbons 33×10^6 Tons	Nitrogen Oxides 21×10^6 Tons	Particulates 28×10^6 Tons
Fuel burning for transportation	63.8%	2.4%	51.9%	39.3%	4.3%
Fuel burning in power plants, home furnaces and other stationary sources	1.9	73.5	2.2	48.5	31.4
Industrial processes other than fuel burning, including petroleum refining	9.6	22.0	14.4	1.0	26.5
Solid waste disposal	7.3	0.3	5.0	2.9	3.9
Forest fires, coal waste fires, agricultural burning, gasoline marketing, etc.	16.9	1.8	26.5	8.3	33.9

ENERGY SOURCES AND DEVELOPMENT

TEST

I. Indicate correct response to the following statements by circling "T" for true statements and "F" for those statements which are false.

T F 1. Hydrocarbons comprise major compounds of petroleum family.

T F 2. Fossil fuels are formed as the result of partial decomposition of living matter.

T F 3. Conversion of organic sediments to fossil fuels takes only a few hundred years to occur.

T F 4. Petroleum is usually dispersed in sea water as it forms.

T F 5. Hydrocarbon compounds vary little in weight and composition.

T F 6. Methane is found as a gas under normal conditions of temperature and pressure.

T F 7. Natural seeps of petroleum have been known since ancient times.

T F 8. Petroleum products have been in widespread use for less than a hundred years.

T F 9. Basic techniques related to drilling for oil have changed very little from early days of the industry.

T F 10. A growing scarcity of whale oil and other illuminants led to initial exploration for petroleum.

T F 11. Advent of internal combustion engine had little influence on advances in petroleum usage.

T F 12. Petroleum is generally processed through a refinery before using.

T F 13. Quantity of sulfur in oil has little effect on refining process used.

T F 14. During early developmental years of the petroleum industry, natural gas was immediately utilized by the public.

T F 15. Delivery of natural gas to consumers was a technological situation that had to be overcome by the petroleum industry.

T F 16. Petroleum and natural gas often are discovered together in drilling wells for oil.

T F 17. Natural gas is often described as a "clean fuel".

T F 18. Today, natural gas is the most highly sought after fuel for both home and industrial purposes.

T F 19. The formation of coal resulted from partial decay of plant materials.

T F 20. Humidified materials and plant remains combine to form peat.

T F 21. Ratio of peat material compacts to form coal is expressed as 100-1.

T F 22. Type of coal formed is not affected by the type of plant residue from which it is formed.

T F 23. Rank of coal (quality) is correlated with the depth of sediment in which it is formed.

T F 24. Anthracite coal is the lowest rank of coal known to man.

T F 25. Lignite coal was formed less than 150 million years ago.

T F 26. Bituminous coal is typified by being hard and brittle, burning with a hot and smokeless flame.

T F 27. Oil shale differs from coal in that it contains a high degree of inorganic matter.

T F 28. Coal use on a wide scale resulted from a growing scarcity of wood.

T F 29. Use of coal is primarily limited to industrial use only.

T F 30. The Clean Air Act of 1970 has little effect on production of coal.

T F 31. Low sulfur coal is probably the most desirable form of coal.

T F 32. Most low-sulfur coal is found in the western states of America.

T F 33. The coal mined in the eastern part of the United States is primarily used for production of metallurgical coke.

T F 34. Black lung disease has little lasting effect on coal miners.

T F 35. Nuclear fuels can be classified as fission and fusion fuels.

T F 36. Geothermal energy is formed when coal is burned underground.

T F 37. Electricity as an energy source is usually the result of conversion of available fuel sources.

II. Match terminology with definitions below by placing letter of correct response in space provided beside definition.

_____ 38.	Removing impurities of sulfur from crude petroleum	A. "Wild-catting"
_____ 39.	Process of fractional distillation applied to petroleum	B. Methane
_____ 40.	Use of shock artifically produced in geophysical prospecting	C. Sweet-crude
_____ 41.	Oil well drilling in area not known to be productive	D. Refining
_____ 42.	Hydrocarbon oil previously used for illumination now used as component of jet fuel	E. Sweetening process
_____ 43.	Gaseous hydrocarbon occuring naturally in decomposition of organic matter	F. Seismic
_____ 44.	High sulfur content crude oil	G. Sour-crude
_____ 45.	Organic compounds containing only carbon and hydrogen	H. Kerosene
_____ 46.	Low sulfur content crude oil	I. Hydrocarbons
		J. Gravitational effect

III. Select the term that best fits the definition below. Place correct letter in space provided beside the definition.

_____ 47. Conversion of coal to gaseous fuel

_____ 48. Brownish-black coal whose formation indicates it is the "youngest" of the coals formed.

_____ 49. Mining disease due to excess inhalation of coal dust

_____ 50. Coal of highest grade

_____ 51. Conversion of coal to liquid hydrocarbon

_____ 52. Marsh gas

_____ 53. Cave-ins caused by underground mining

_____ 54. Mining technique used to uncover underlying coal seams

_____ 55. Conversion of plant material to coal

_____ 56. First layer of coal and the last to devlop

A. black lung
B. liquefaction
C. methane
D. gasification
E. subsidence
F. "strip-mining"
G. anthracite
H. lignite
I. entrophication
J. humidification
K. peat

57. Original uses for petroleum were different than today's uses for fossil fuel. What are the three early uses discussed in this unit?

A.

B.

C.

58. Current explorations for petroleum have ranged into areas other than those previously considered. Name three areas being given current consideration.

A.

B.

C.

59. From the point of view of the coal industry, what are the advantages of strip-mining over conventional underground techniques for mining coal?

60. Briefly describe the process of strip-mining.

ENERGY SOURCES AND DEVLOPMENT

ANSWERS TO TEST

I. 1. T
2. T
3. F
4. T
5. F
6. T
7. T
8. T
9. F
10. T
11. F
12. T
13. F
14. F
15. T
16. T
17. T
18. T
19. T
20. T
21. F
22. T
23. T
24. F
25. T
26. F
27. T
28. T
29. T
30. F
31. F
32. T
33. T
34. F
35. T
36. F
37. T
38. E
39. D
40. F
41. A
42. H
43. B
44. G
45. I
46. C

III. 47. D

48. H

49. A

50. G

51. B

52. C

53. E

54. F

55. J

56. K

57. Original uses for petroleum were different than today's uses for fossil fuel. What are the three early uses discussed in this unit?

A. Kerosene as an illuminant

B. Lubricating oil

C. Oil for medicinal purposes

58. Current explorations for petroleum have ranged into areas other than those previously considered. Name three areas being given current consideration.

A. Desert areas

B. Ocean floor

C. Subpolar regions

59. From the point of view of the coal industry, what are the advantages of strip-mining over conventional underground techniques for mining coal?

1. Hand labor replaced by machine

2. Coal could sell cheaper

3. Less danger to miners

60. Briefly describe the process of strip-mining.

This process involves the removal of overburden of soil, shale, rock, etc. in order that the coal may be removed. This usually leaves the land in a rough condition. Once the coal is removed the overburden is then dumped on the excavated area. In the past these strip mines were very unsightly and did not promote good vegetation growth.